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Factor Intensity of U.S. Agricultural Trade

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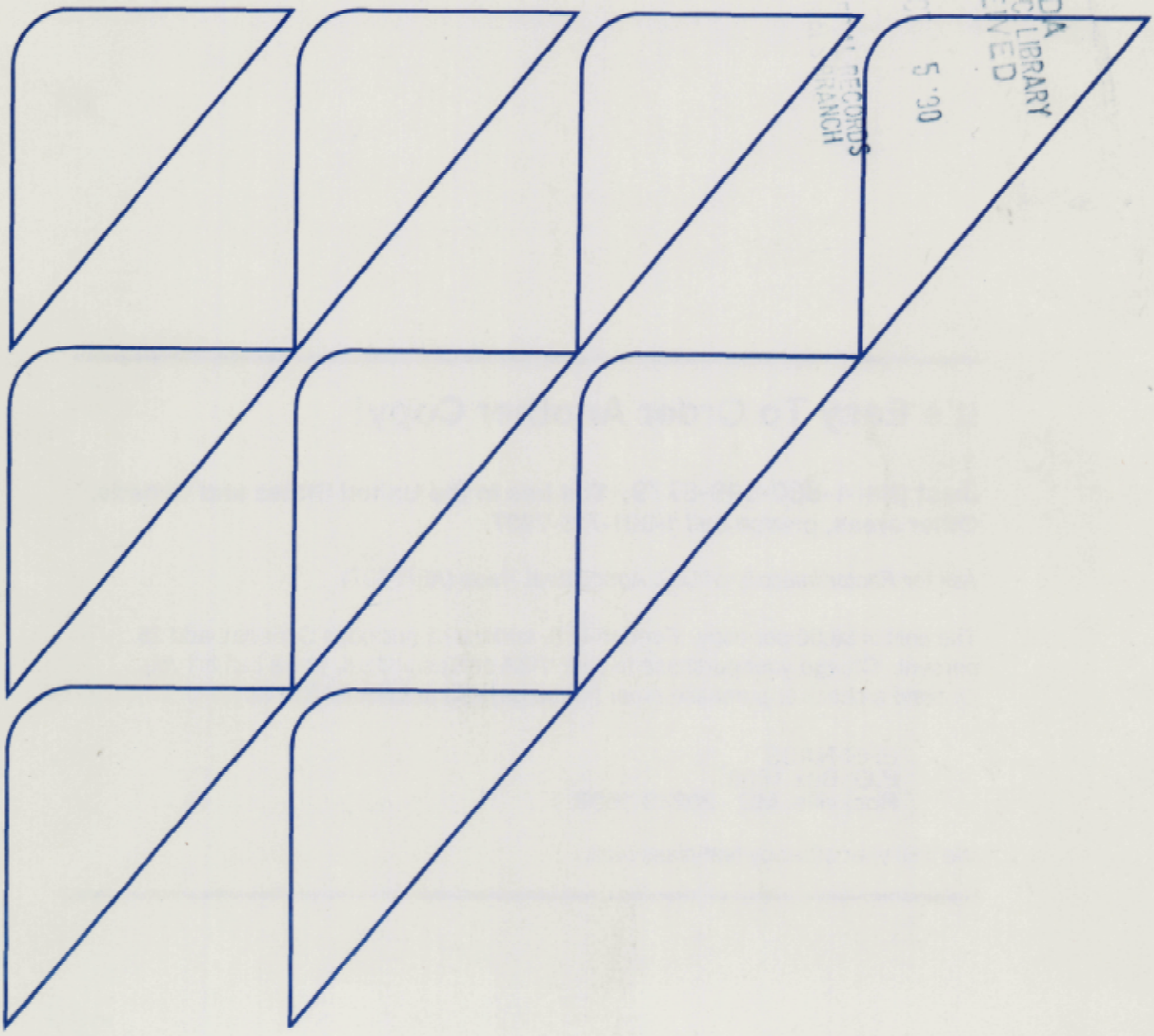

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Abstract

U.S. agricultural exports in 1987 employed an estimated 884,000 workers throughout the economy and an estimated 107 million acres of harvested cropland. Factor intensity is defined as the amount of a factor (land, labor, or capital) required economywide to produce $1 million of agricultural exports. In 1987, for each $1 million, U.S. agricultural exports required approximately 31 workers and 3,500 harvested acres, compared with 39 workers and 4,300 harvested acres in 1977. These changes in factor intensity reflect changes in prices, commodity composition, and factor productivity. Compared with agricultural imports, U.S. agricultural exports are capital and land intensive.

Keywords: Input-output, employment, harvested acres, agricultural exports, factor intensity

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Summary

U.S. agricultural exports in 1987 employed an estimated 884,000 workers throughout the economy and an estimated 107 million acres of harvested cropland. Factor intensity is defined as the amount of a factor (land, labor, or capital) required economywide to produce $1 million of agricultural exports. In 1987, for each $1 million, U.S. agricultural exports required approximately 31 workers and 3,500 harvested acres, compared with 39 workers and 4,300 harvested acres in 1977. These changes in factor intensity reflect changes in prices, commodity composition, and factor productivity.

U.S. agricultural exports are an important user of the productive factors of land, labor, and capital in the U.S. economy. The United States exported $28.6 billion worth of agricultural products in 1987. Of the estimated 884,000 workers employed in the production of these items, 40 percent were farmworkers and another 7 percent worked in agricultural services. The food processing industries employed 6 percent.

Agricultural exports include a wide range of products, from farm produce to processed foods to industrial raw materials. The composition of exports changed between 1977 and 1987. Food, feed, and oil crops accounted for 53 percent of the value of agricultural exports in 1977, 57 percent in 1982, and 41 percent in 1987.

The composition of exports reflects the pattern of purchases by different nations. Over time, these patterns change as nations alter their purchases in response to factors such as changes in income, relative price changes, and domestic shortages. Perhaps the most important of these factors is changes in income resulting from the development process. As a nation develops, its agricultural imports tend to shift away from food grains and industrial raw materials toward high-value products, such as meat products and fruits and vegetables.

As developing nations experience higher incomes and become increasingly self-sufficient in food production, the composition of U.S. agricultural exports will likely shift toward meats, fruits and vegetables, and other processed foods. However, crops used to produce livestock, feed grains, and oil crops will likely also remain a major share of agricultural exports. Changes in the commodity composition of agricultural exports can have an important effect on factor use because different commodities have different direct and economywide factor requirements.

An interesting issue in the theory of international trade is the Leontief Paradox, which states that despite an abundance in U.S. capital, U.S. exports are more labor intensive than U.S. imports. By comparing the land, labor, and capital purchases associated with the production of agricultural exports and imports, this study finds that, contrary to the Leontief Paradox, U.S. agricultural exports are more land and capital intensive than imports.

Factor Intensity of U.S. Agricultural Trade

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Introduction

Agricultural trade has become increasingly important for the United States. Although the United States was a net importer of goods and services throughout 1983-87, it was a net exporter of agricultural goods. Thus, agricultural trade has to some degree offset the trade deficit for nonagricultural products. More fundamentally, agricultural trade is important to the U.S. economy because it provides employment and generates income for hundreds of thousands of workers. Each million dollars of agricultural exports directly and indirectly requires significant amounts of land, labor, and capital. We refer to these measures of factor use per million dollars of exports as the factor intensity of agricultural exports. Between 1977 and 1987, the commodity mix of U.S. agricultural exports changed somewhat as foreign buyers shifted their demand away from feed grains and oil crops toward vegetables, fruits, nuts, and processed foods such as meat products.

This report examines the changes in the commodities exported to different regions and the implications of these changes for factor use in the U.S. economy. We estimate the land, labor, and capital used to produce U.S. agricultural exports for 1977, 1982, and 1987. In addition, for 1987, we estimate the factors used to produce agricultural products exported to several countries and regions that are important markets for U.S. agricultural products.

This report also discusses an important issue in international trade theory: the Leontief Paradox. Wassily Leontief's paradoxical finding states that in spite of U.S. capital abundance, U.S. exports are more labor intensive than U.S. imports. We compared estimates of factor use required to domestically produce agricultural imports with factor use for agricultural exports. We found that, contrary to the Leontief Paradox, U.S. agricultural exports are more land and capital intensive than agricultural imports.

The factor intensity of U.S. agricultural trade is estimated using an input-output (I-O) model of the U.S. economy. An I-O model traces the production flows required to produce output purchased by consumers, government, businesses, and foreign buyers. The I-O model's usefulness lies in its ability to account for the production of goods and services generated

directly and indirectly to meet the final demands of buyers. For example, producing wheat for export requires fertilizers, pesticides, and fuels. Moving commodities between producers and ultimately to the final buyers requires trade and transportation services. Using the I-O model, it is possible to estimate the supporting production required from each industry to produce the agricultural exports in a given year. Combining this information on required output with information on average land, labor, and capital requirements per unit of output in each industry yields estimates of the factor use required to produce those exports.

The Commodity Composition of U.S. Agricultural Exports

The United States exported $29 billion worth of agricultural products in 1987 (table 1) (11).[1] Agricultural exports include a wide range of different products, ranging from farm products such as wheat and corn to processed commodities such as meat products and canned fruits and vegetables. Commodities classified as agricultural are nonmarine food products and farm products that have not gone through complex manufacturing processes. In addition to fruit, grains, and fibers, agricultural exports include commodities such as hides and skins, fats and oils, and beer and wine. However, agricultural exports do not include manufactured products such as textiles, cigarettes, and distilled alcoholic beverages (11).

Food grains, feed crops, and oil crops (primarily wheat, corn, and soybeans, respectively) formed the bulk of U.S. agricultural exports in 1977, comprising 53 percent of the total (fig. 1). Cotton and tobacco exports amounted to 11 percent of the total, and vegetables, fruits, and nuts were 4 percent of the value of exports. Livestock and meat products were 7 percent and other processed products (including feeds, flours, fats, oils, and other agricultural products) accounted for 25 percent of agricultural exports. By 1987, the importance of these commodities had changed. Food, feed, and oil crops accounted for only 41 percent of agricultural exports, and the share of cotton and tobacco declined to less than 10 percent (fig. 2). In contrast, vegetables, fruits, and nuts rose to 7 percent, livestock and meat products rose to 13 percent, and processed foods and other products increased to 30 percent of agricultural exports.

The composition of U.S. agricultural exports reflects the exports to the different foreign purchasers of U.S. commodities. Foreign countries buy different products from the United States depending on their tastes, incomes, and level of development, and on unpredictable supply shocks such as droughts.

Japan is the single largest importer of U.S. agricultural products, importing $5.7 billion worth in 1987 (table 1). Meat

[1] Underscored numbers in parenthesis refer to References listed at the end of this report.

Table 1--U.S. agricultural exports, by destination, 1977-87, selected years

Commodity	World			Canada			Mexico			Western Europe		
	1977	1982	1987	1977	1982	1987	1977	1982	1987	1977	1982	1987
	1,000 dollars											
Livestock	209,526	439,696	538,515	39,522	45,414	49,163	21,563	53,014	40,085	46,273	197,567	218,857
Food grains	2,732,232	6,698,159	3,051,070	1,182	1,026	713	41,252	72,624	13,470	210,869	552,282	94,090
Feed grains	4,912,549	6,487,406	3,974,575	36,339	44,220	27,782	247,828	204,481	342,435	2,072,751	1,826,558	227,339
Cotton	1,534,787	1,965,018	1,638,556	69,079	56,815	34,272	160	330	28,945	222,303	265,407	351,187
Vegetables, fruits, and nuts	975,599	1,744,838	1,965,952	376,146	536,589	454,359	13,102	107,984	40,260	250,552	392,796	571,782
Oil crops	4,791,941	6,802,370	4,589,803	149,549	116,315	71,744	115,699	270,873	263,340	2,751,069	4,137,652	2,184,619
Tobacco	1,094,283	1,546,541	1,089,990	3,677	8,898	1,670	0	8	37	480,591	754,477	523,724
Meat products	1,514,582	2,138,167	3,287,490	211,343	136,651	197,496	71,991	142,203	170,924	368,739	346,728	318,256
Feeds and flours	1,560,210	2,345,206	2,315,168	96,219	138,715	126,930	8,668	21,421	21,869	492,078	867,529	1,102,897
Vegetable fats and oils	2,334,085	2,998,347	2,204,718	122,101	108,608	189,241	92,936	121,710	102,424	813,988	1,189,371	625,655
Other processed foods	1,407,275	2,526,209	2,918,708	318,929	454,466	451,042	29,871	90,844	108,401	385,038	548,392	635,602
Other agricultural products	569,087	930,642	1,062,848	110,389	172,155	205,087	21,333	70,788	68,383	264,217	384,659	409,744
Total agricultural products	23,636,156	36,622,599	28,637,393	1,534,475	1,819,872	1,809,499	664,403	1,156,280	1,200,573	8,358,468	11,463,418	7,263,752

Commodity	Japan			South Korea			USSR			Africa		
	1977	1982	1987	1977	1982	1987	1977	1982	1987	1977	1982	1987
	1,000 dollars											
Livestock	24,700	35,120	54,727	8,211	11,129	4,063	272	0	635	1,252	6,674	8,476
Food grains	374,516	563,681	352,338	202,224	300,153	213,531	427,897	802,182	392,491	396,338	877,044	713,852
Feed grains	1,065,621	1,515,787	1,221,625	158,475	378,716	357,072	387,642	834,626	393,230	118,662	273,678	225,409
Cotton	310,069	502,468	416,908	315,251	425,507	313,725	453	67	0	65,105	17,586	58,341
Vegetables, fruits, and nuts	123,825	247,374	441,051	128	1,468	5,012	13,349	7,680	20,247	19,796	31,121	31,772
Oil crops	964,673	1,003,987	809,511	44,280	142,255	232,637	159,031	171,265	42,705	36,359	40,956	21,225
Tobacco	259,953	309,920	300,766	21,159	4,183	845	0	1,262	0	96,375	76,890	29,034
Meat products	396,908	773,927	1,281,818	108,125	170,575	608,599	7,611	5,061	0	22,130	36,971	39,964
Feeds and flours	64,615	88,304	186,406	11,929	68,074	7,890	24,114	1	0	252,551	479,829	270,375
Vegetable fats and oils	130,002	111,899	56,408	40,116	50,488	45,726	1,599	40,571	76,356	262,829	281,559	235,888
Other processed foods	113,076	336,336	489,707	5,811	17,979	22,047	4,656	6,791	11,298	75,872	96,375	116,663
Other agricultural products	28,831	66,210	88,570	3,576	10,833	22,273	9,959	1,768	1,145	15,017	19,092	15,362
Total agricultural products	3,856,789	5,555,013	5,699,835	919,285	1,581,360	1,833,420	1,036,583	1,871,274	938,107	1,362,286	2,237,775	1,766,361

Figure 1
U.S. agricultural exports, 1977

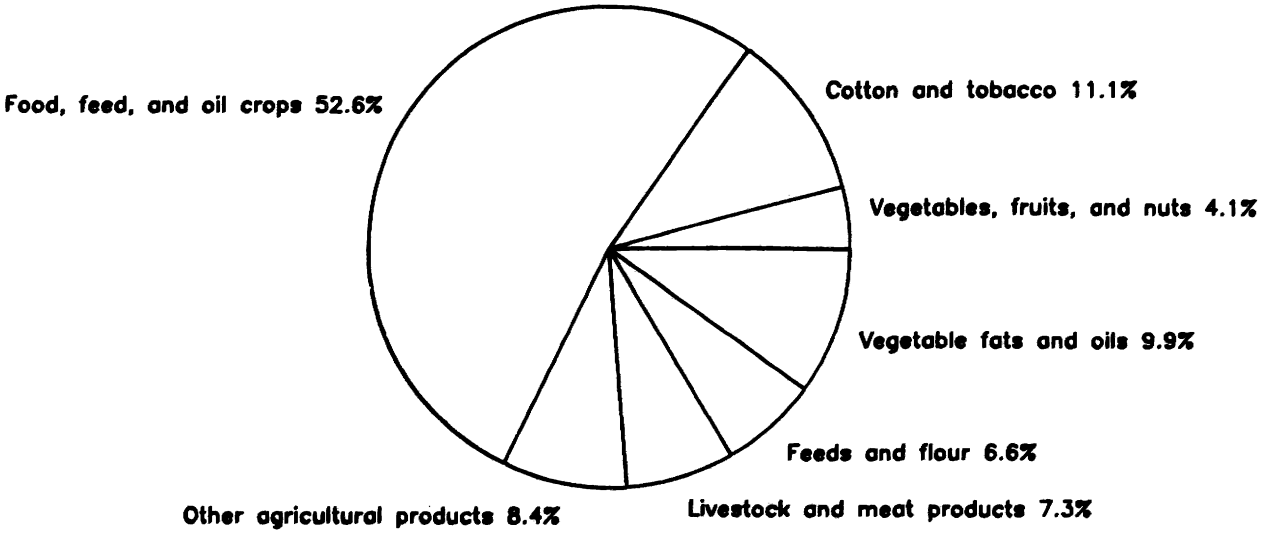
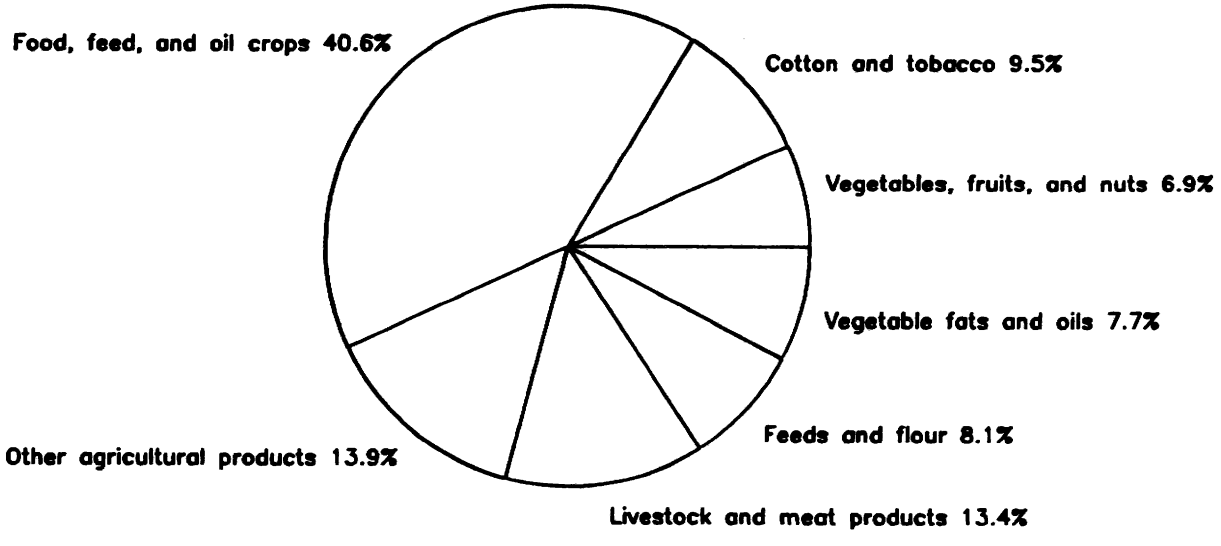


Figure 2
U.S. agricultural exports, 1987



products were their largest import item, followed closely by feed grains. Together, at least 44 percent of U.S. agricultural exports to Japan supported Japanese meat consumption, either by direct imports or by feed grain imports used in the Japanese cattle industry. In addition, oil crops, primarily soybeans, accounted for another 14 percent of U.S. agricultural exports to Japan.

In contrast, Western Europe's primary imports are oil crops and feed and flour preparations. Together, these three commodity groups accounted for 45 percent of the $7.3 billion in U.S. agricultural exports to Western Europe in 1987. In 1987, one-half of Canada's agricultural imports from the United States were vegetables, fruits, nuts, and processed foods.

Developed countries generally tend to import high-value products such as fruits, vegetables, meat products, and other processed foods (fig. 3). Agricultural exports to developing countries, however, display different patterns (fig. 4). Oil crops and feed grains are much less important but food grains are much more important. For example, in 1982, food grains accounted for 39 percent of U.S. agricultural exports to Africa and feeds and flour products for another 21 percent (table 1).

The case of South Korea provides an interesting example of how import demand changes as a country develops economically. For example, in 1977, food grains were 22 percent, cotton 34 percent, and feed grains 17 percent of agricultural imports from the United States (table 1). During 1977-87, Korean per capita real gross domestic product increased by 79 percent and the composition of imports changed notably (3). In 1987, as South Korea approached self-sufficiency in rice production, food grains were only 12 percent of the total. Cotton imports fell to 17 percent of the total as Korean manufacturing broadened beyond textile production. Meat products rose to 33 percent of the value of agricultural imports from the United States compared with only 12 percent in 1977. The experience of South Korea thus provides one picture of how import demand changes as a country's level of development rises. Higher income leads to increased consumption of meat products. Food grains and raw materials such as cotton become less important while meat products and feed grains to support livestock production become more important.

In contrast, the recent experience of Africa shows the reverse. During the 1980's, many African nations experienced economic stagnation and falling incomes. In addition, recurring drought lowered agricultural production (3, 7). As a result, total agricultural imports from the United States fell over 20 percent between 1982 and 1987 and the composition of the remaining imports changed (table 1). Food grains, for example, increased from 29 percent of the total in 1977 to 40 percent in 1987.

At lower income levels, food becomes relatively more important in a nation's consumption budget. Food grains, a lower cost source of calories, account for a larger share of imports. Similarly, temporary supply shocks, such as drought, can change the

Figure 3

U.S. agricultural exports to developed nations, 1982

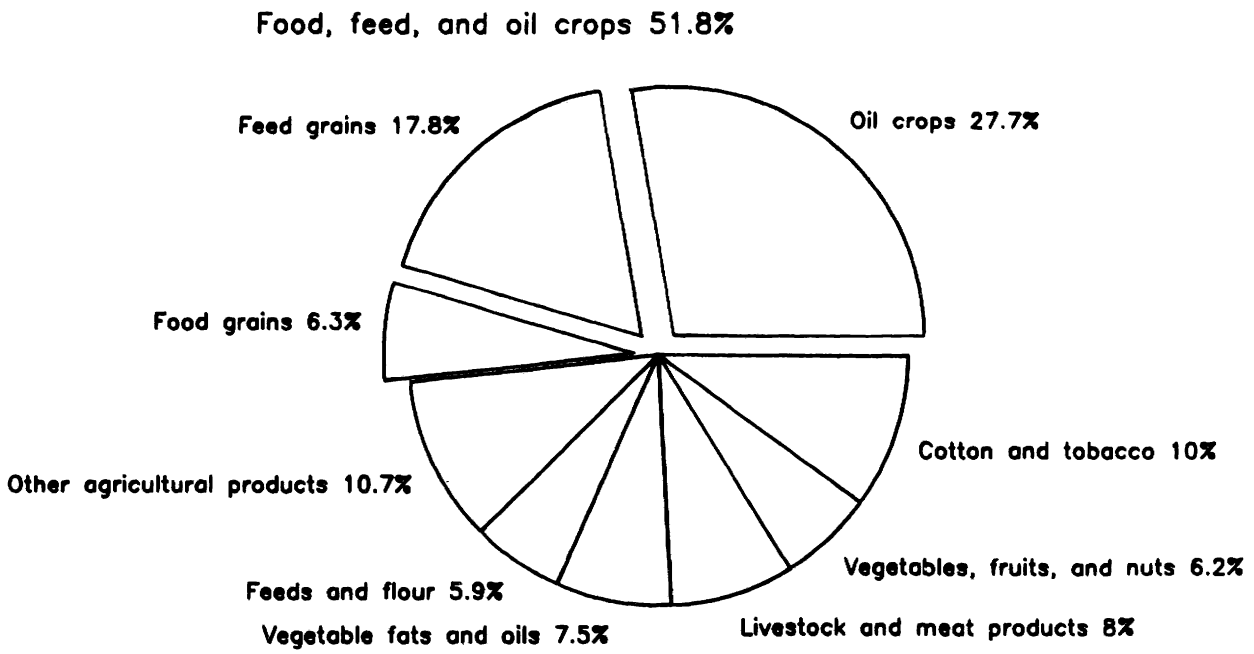
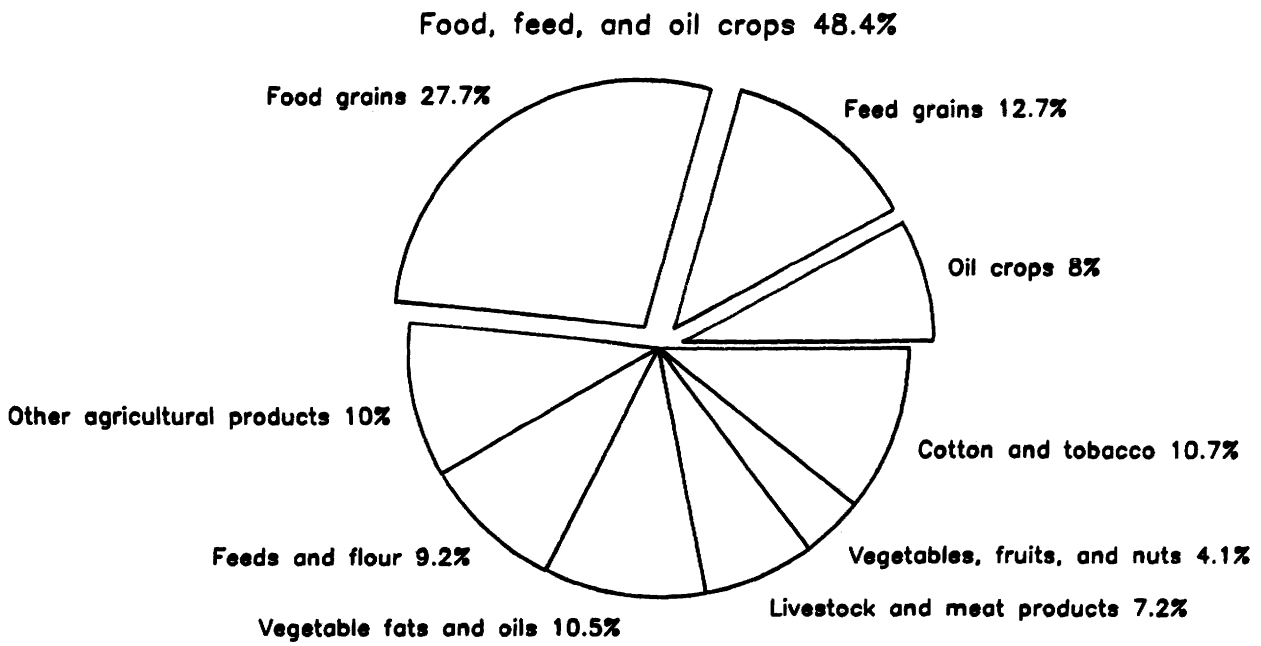


Figure 4

U.S. agricultural exports to developing nations, 1982



composition of imports. For example, poor weather in Mexico led to a major increase in corn imports from the United States in 1982 (12).

Thus, the changing commodity composition of U.S. agricultural exports reflects both the different patterns of exports to various countries and changes in import demand resulting from changes in the level of development and income in individual nations. As more countries successfully increase their income levels, agricultural exports from the United States may continue to shift away from food grains and toward feed crops and such high-value products as fruits, vegetables, and processed foods (13).

Factor Intensity of U.S. Agricultural Exports

As the level and commodity mix of agricultural exports change, the demand for factors of production changes in response. Producers of agricultural commodities use large amounts of land, labor, and capital. Because exports are a major outlet for agricultural production--in many years over 60 percent of U.S. wheat and half of U.S. soybeans were exported--they are a major determinant of factor use in U.S. agriculture. As a means of measuring this factor use, this report uses an input-output analysis to estimate the total economywide production required to meet agricultural exports. Then, using information on factor requirements in each industry, it estimates the land, labor, and capital needed to produce the agricultural exports.[2] Different agricultural products use the factors of production in different combinations. Thus, as the composition of exports changes, the factor intensity of the export bundle changes accordingly.

Agricultural exports in 1977 provided employment for an estimated 932,000 workers throughout the economy. These exports required harvesting an estimated 102 million acres (table 2). As expected, the estimates of factor use rise and fall with the volume of exports. With higher exports in 1982, estimated factor use rose to 1.1 million workers and 130 million harvested acres of cropland. In 1987, exports fell and estimated factor use fell to 884,000 workers and 101 million harvested acres.

Agricultural exports to Japan, the largest buyer of U.S. agricultural products, provided employment to over 180,000 American workers, and required nearly 19 million harvested acres of cropland in 1987 (table 3). The factor use estimates for 1987 agricultural exports to Canada and to South Korea provide a good example of how the commodity composition of exports affects estimates of factor use. Both countries imported $1.8 billion of U.S. agricultural products in 1987. However, exports to South Korea employed 64,000 U.S. workers and required over 7 million harvested acres while agricultural exports to Canada required the services of 51,000 workers and less than 2 million acres of land.

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[2] See the appendices for details on methods and data.

Table 2--Factors used to produce U.S. agricultural exports, 1977-87, selected years

Commodity	Workers			Harvested acreage		
	1977	1982	1987	1977	1982	1987
	Number			Acres		
Livestock	13,497	20,944	21,462	541,215	670,770	742,730
Food grains	126,191	201,703	126,888	28,947,020	44,191,519	30,993,956
Feed grains	197,727	202,202	154,242	30,242,048	28,671,191	24,110,925
Cotton	67,195	80,986	73,107	4,362,965	5,257,663	4,198,066
Vegetables, fruits, and nuts	64,316	65,741	64,619	787,582	856,145	831,463
Oil crops	122,722	161,808	116,735	22,504,891	34,373,282	25,730,779
Tobacco	39,438	28,924	12,325	127,054	89,548	42,932
Meat products	78,772	72,140	100,605	2,943,985	2,519,791	3,615,441
Feeds and flours	58,065	65,306	56,828	4,287,406	4,739,529	4,247,284
Vegetable fats and oils	79,114	90,173	62,172	5,779,622	7,066,934	4,999,326
Other processed foods	59,831	68,225	63,476	806,824	831,666	797,205
Other agricultural products	25,490	31,197	31,869	250,929	272,758	367,983
Total agricultural products	932,358	1,089,349	884,327	101,581,541	129,540,796	100,678,087

The major difference in land requirements results from the different composition of commodities to the two countries. Food grains, feed grains, and oil crops, all crops that use land intensively, figure prominently in exports to South Korea (table 1). In contrast, Canada imports hardly any of these commodities. It buys U.S. vegetables, fruits, and nuts, commodities that use much less land.

These estimates of total factor use for exports for specific years and to specific regions reflect the different volume of exports between years and regions. Factor intensity is a measure of factor use that does not depend on the total value of exports for a given year or region. Instead, factor intensity measures the factor use per million dollars of agricultural exports. With factor intensity measures, it becomes possible to analyze differences in factor use for exports during different years or for exports to different countries despite differences in the level of trade.

Differences in estimates of factor intensity reflect differences in the composition of agricultural exports better than do differences in estimates of total factor use. Table 4 shows the actual value of 1987 agricultural exports and a representative $1 million bundle of those exports. This representative bundle emphasizes the commodity composition of exports, whether total or to a given region, by demonstrating the relative importance of the various commodities. Because it gives numerically significant estimates of factor use, the $1 million bundle is useful for analyzing factor intensity. For example, $1 million of agricultural exports in 1987 required the services of approximately 31 workers.

Table 3--Factors used to produce U.S. agricultural exports, by destination, 1987

Commodity	World		Canada		Mexico		Western Europe	
	Workers	Harvested acreage	Workers	Harvested acreage	Workers	Harvested acreage	Workers	Harvested acreage
	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Livestock	21,462	742,730	1,844	67,010	1,169	54,811	9,553	324,485
Food grains	126,888	30,993,956	30	7,243	560	136,833	3,913	955,803
Feed grains	154,242	24,110,925	1,078	168,534	13,289	2,077,310	8,822	1,379,104
Cotton	73,107	4,198,066	1,529	87,807	1,291	74,159	15,669	899,759
Vegetables, fruits, and nuts	64,619	831,463	14,337	169,688	1,225	19,192	19,159	303,687
Oil crops	116,735	25,730,779	1,825	402,202	6,698	1,476,304	55,562	12,247,137
Tobacco	12,325	42,932	19	66	0	1	5,922	20,628
Meat products	100,605	3,615,441	6,044	217,198	5,231	187,975	9,739	350,004
Feeds and flours	56,828	4,247,284	3,135	226,862	537	40,190	27,011	2,042,599
Vegetable fats and oils	62,172	4,999,326	5,336	429,115	2,888	232,252	17,643	1,418,709
Other processed foods	63,476	797,205	9,532	93,246	2,544	62,584	13,909	135,364
Other agricultural products	31,869	367,983	6,273	43,947	2,199	43,955	12,402	144,444
Total agricultural products	884,327	100,678,087	50,981	1,912,916	37,631	4,405,566	199,306	20,221,724

	Japan		South Korea		USSR		Africa	
	Workers	Harvested acreage	Workers	Harvested acreage	Workers	Harvested acreage	Workers	Harvested acreage
	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Livestock	2,146	79,269	153	4,145	19	931	319	11,713
Food grains	14,653	3,579,186	8,880	2,169,131	16,323	3,987,076	29,688	7,251,586
Feed grains	47,408	7,410,732	13,857	2,166,102	15,260	2,385,447	8,748	1,367,396
Cotton	18,601	1,068,140	13,997	803,780	0	0	2,603	149,473
Vegetables, fruits, and nuts	15,006	154,843	171	2,564	708	13,605	904	14,423
Oil crops	20,589	4,538,179	5,917	1,304,180	1,086	239,407	540	118,989
Tobacco	3,401	11,846	10	33	0	0	328	1,144
Meat products	39,226	1,409,689	18,624	669,311	0	0	1,223	43,951
Feeds and flours	4,679	309,128	195	14,005	0	0	6,595	509,180
Vegetable fats and oils	1,591	127,908	1,289	103,686	2,153	173,142	6,652	534,890
Other processed foods	10,810	109,231	481	4,865	226	3,006	2,581	54,700
Other agricultural products	2,705	42,034	603	3,605	32	31	504	10,362
Total agricultural products	180,815	18,840,185	64,178	7,245,408	35,807	6,802,645	60,684	10,067,806

Table 4--U.S. agricultural exports, 1987: Actual value and commodity composition for $1 million in exports

Commodity	Actual value	Composition for $1 million in exports
	1,000 dollars	Dollars
Livestock	538,515	18,804
Food grains	3,051,070	106,541
Feed grains	3,974,575	138,790
Cotton	1,638,556	57,217
Vegetables, fruits, and nuts	1,965,952	68,649
Oil crops	4,589,803	160,273
Tobacco	1,089,990	38,062
Meat products	3,287,490	114,797
Feeds and flours	2,315,168	80,845
Vegetable fats and oils	2,204,718	76,987
Other processed foods	2,918,708	101,919
Other agricultural products	1,062,848	37,114
Total agricultural products	28,637,393	1,000,000

Each million dollars of 1977 agricultural exports required an estimated 39 workers throughout the U.S. economy and an estimated 4,300 acres of harvested cropland (table 5). Factor intensities dropped for 1982 exports, with each million dollars requiring only 30 workers and 3,500 harvested acres. The factor intensity of 1987 exports changed little with labor intensity rising and land intensity falling slightly. Changes in estimated factor intensity between years result from changes in three determinants: commodity composition, commodity prices, and labor and land productivity.

First, estimates of factor intensity reflect the composition of agricultural exports in each year. Since different commodities require the services of labor and land in different combinations, the factor intensity of agricultural exports changes when the composition of those exports changes. For example, $1 million of 1977 oil crop exports required approximately 20 workers throughout the economy and an estimated 4,695 harvested acres. Similarly, $1 million dollars of 1977 feed crops required an estimated 32 workers and 6,154 harvested acres. In contrast, $1 million of fruit exports required 60 workers and only 555 bearing acres.

In general, food, feed, and oil crops have low labor intensities and high land intensities. High-value crops such as fruits, vegetables, and nuts have higher labor intensities but much lower land intensities. Processed foods such as meat products, fats, oils, and feed and flour products use land-intensive farm products as inputs and thus have moderate land intensities. For example, $1 million each of fats and flour product exports in 1977 required 2,475 and 2,831 harvested acres of mostly oil crops and food grains, respectively. Because of these differences in production requirements, changes in the commodity mix of exports from year to year contribute to changes in the factor intensity of agricultural exports.

Table 5--Factor use per million dollars in agricultural exports: 1977, 1982, 1987

Commodity	1977		1982		1987	
	Employment	Harvested acreage	Employment	Harvested acreage	Employment	Harvested acreage
	Workers	Acres	Workers	Acres	Workers	Acres
Livestock	1	23	1	18	1	26
Food grains	5	1,225	6	1,207	4	1,082
Feed grains	8	1,279	6	783	5	842
Cotton	3	185	2	144	3	147
Vegetables, fruits, and nuts	3	33	2	23	2	29
Oil crops	5	952	4	939	4	899
Tobacco	2	5	1	2	0	1
Meat products	3	125	2	69	4	126
Feeds and flours	2	181	2	129	2	148
Vegetable fats and oils	3	245	2	193	2	175
Other processed foods	3	34	2	23	2	28
Other agricultural products	1	11	1	7	1	13
Total agricultural exports	39	4,298	30	3,537	31	3,516

Changes in commodity prices also contribute to observed changes in factor intensity between years. Factor intensity is an estimate of factor use per million dollars of exports, measured in current dollars. Because of price changes, however, $1 million in 1 year does not buy the same amount of commodities as in another. For example, because most commodity prices were higher in 1982 than in 1977, $1 million bought a smaller quantity of output in 1982. Since the volume of production rather than its value determines factor use, this results in a smaller estimate of factor intensity.

Further, observing changes in commodity composition is complicated by the fact that not all commodity prices change at the same rate. To more accurately compare the composition of exports between years, we must adjust the export values to a common dollar basis by valuing them in 1977 prices (table 6). Measured in current dollars, the shares of feed grains and oil crops fell from 20.8 and 20.3 percent, respectively, in 1977 to 17.7 and 18.6 percent of 1982 agricultural exports. However, when valued in 1977 prices, the 1982 share of feed grains fell to 18.1 percent and the share of oil crops rose to 23.8 percent.

The share of food grains also rose from 1977 to 1982 when measured in 1977 dollars. The real increase in the food grain share represents a shift toward the most land-intensive commodity (wheat) and was large enough to offset the real decline in the feed grain share. As a result, one would expect these shifts to result in a higher overall land intensity for agricultural exports.

In spite of the shift in commodity composition toward the more land-intensive food crops, the overall land intensity of 1982 agricultural exports actually fell (table 5). This result points to the importance of the third element responsible for changes in factor intensity, factor productivities. As workers become more productive, fewer are needed to produce a given amount of output.

Table 6--Current and constant value of U.S. agricultural exports, 1977-87, selected years

Commodity	Current value			Share of agricultural exports		
	1977	1982	1987	1977	1982	1987
	Dollars			Percent		
Livestock	209,526	439,696	538,515	0.9	1.2	1.9
Food grains	2,732,232	6,698,159	3,051,070	11.6	18.3	10.7
Feed grains	4,912,549	6,487,406	3,974,575	20.8	17.7	13.9
Cotton	1,534,787	1,965,018	1,638,556	6.5	5.4	5.7
Vegetables, fruits, and nuts	975,599	1,744,838	1,965,952	4.1	4.8	6.9
Oil crops	4,791,941	6,802,370	4,589,803	20.3	18.6	16.0
Tobacco	1,094,283	1,546,541	1,089,990	4.6	4.2	3.8
Meat products	1,514,582	2,138,167	3,287,490	6.4	5.8	11.5
Feeds and flours	1,560,210	2,345,206	2,315,168	6.6	6.4	8.1
Vegetable fats and oils	2,334,085	2,998,347	2,204,718	9.9	8.2	7.7
Other processed foods	1,407,275	2,526,209	2,918,708	6.0	6.9	10.2
Other agricultural products	569,087	930,642	1,062,848	2.4	2.5	3.7
Total agricultural products	23,636,156	36,622,599	28,637,393	100.0	100.0	100.0
	Constant value			Share of agricultural exports		
	1977	1982	1987	1977	1982	1987
	1977 dollars			Percent		
Livestock	209,526	315,271	357,248	0.9	1.0	1.3
Food grains	2,732,232	4,777,574	3,593,722	11.6	15.2	12.9
Feed grains	4,912,549	5,705,722	5,082,577	20.8	18.1	18.2
Cotton	1,534,787	2,103,874	1,988,539	6.5	6.7	7.1
Vegetables, fruits, and nuts	975,599	1,145,674	1,157,468	4.1	3.6	4.2
Oil crops	4,791,941	7,499,857	6,047,171	20.3	23.8	21.7
Tobacco	1,094,283	859,667	391,801	4.6	2.7	1.4
Meat products	1,514,582	1,561,846	2,378,792	6.4	5.0	8.5
Feeds and flours	1,560,210	1,975,742	1,910,205	6.6	6.3	6.9
Vegetable fats and oils	2,334,085	2,974,551	2,272,905	9.9	9.5	8.2
Other processed foods	1,407,275	1,803,461	1,863,010	6.0	5.7	6.7
Other agricultural products	569,087	748,248	838,981	2.4	2.4	3.0
Total agricultural products	23,636,156	31,471,486	27,882,419	100.0	100.0	100.0

Similarly, as crop yields rise, less land is required to produce a given amount of output.

Between 1977 and 1982, output per hour of all workers in the business sector increased by only 0.3 percent (2, table B-46). In farming, however, estimated labor productivity increased by 25 percent (2, table B-97). Crop yields also rose sharply. In particular, bushels per acre of wheat, the predominant food crop, rose 15.6 percent between 1977 and 1982 [14]. Partly as a result of increases in 1982 crop yields, the overall land intensity of 1982 agricultural exports fell to 3,537 harvested acres per million dollars from 4,298 in 1977. Similarly, increases in labor productivity in most sectors of the economy, especially in farming, contributed to the fall in the labor intensity of 1982 agricultural exports from 39 in 1977 to 30 workers per million dollars.

Rising crop yields had a similar effect on the land intensity of 1987 agricultural exports, which fell slightly from the 1982 level to 3,516 acres per million dollars. A decline in the share of food grains from 15.2 to 12.9 percent of exports in 1977 dollars (table 6) caused part of the decline in land intensity. The decline in observed land intensity was not larger because price declines for major crops meant that a million dollars in 1987 bought more products than in 1982. But this effect was not quite large enough to offset the shift away from food grains.

In contrast to land, labor intensity of 1987 agricultural exports rose slightly to 31 workers per million dollars. This increase occurred despite increased labor productivity because of a shift toward more labor-intensive commodities. Food grains and oil crops became less important and the more labor-intensive fruits and vegetables, meat products, and other processed foods became a larger share of total exports (table 6). Contributing to the higher estimated labor use was the effect of lower prices, which means that a dollar of exports represented more output and hence more factor use. Unlike the case of land, however, increased labor productivity did not offset this effect, resulting in a higher labor intensity for 1987 exports.

It is important to understand the effect that price changes have on estimates of factor intensity. We defined factor intensity as factor use per million dollars of exports in current year prices. This is a more natural way than defining it in terms of, say, 1977 prices, but it requires care in comparing factor intensity between years. As explained above, when prices increase, $1 million represents a smaller volume of commodities and hence the measure of factor intensity is lower. But this effect is strictly an artifact of the definition of factor intensity and does not represent some fundamental change in the way commodities are produced. To keep this point clear, we refer to changes in the measures of factor intensity that result from changes in commodity composition and productivity changes as real changes.

Table 7 sets out the direction of changes in factor intensity between 1977, 1982, and 1987 and shows the relative importance to these changes of changes in commodity composition, prices, and factor productivities. For each change in factor intensity

Table 7--Labor and land intensity change, by source of change, 1977-87, selected years 1/

Source of change	Labor intensity			Land intensity		
	1977-82 decline	1982-87 increase	1977-87 decline	1977-82 decline	1982-87 decline	1977-87 decline
			Percent			
Composition	5.0	30.5	-7.6	-44.6	2,192.7	-11.3
Productivity	28.8	-199.6	68.3	68.4	1,021.5	99.0
Total real change	33.8	-169.2	60.7	23.8	3,214.2	87.8
Prices	66.2	269.2	39.3	76.2	-3,114.2	12.2
Total change	100.0	100.0	100.0	100.0	100.0	100.0

1/ The heading under each period indicates the direction of change of factor intensity. For example, during 1977-87, labor intensity declined.

between years, the table presents the share attributable to change in commodity composition, factor productivities, and prices.

For example, the labor intensity of agricultural exports fell between 1977 and 1982 from 39 workers to 30 (table 5). A change in the composition of commodities was responsible for 5 percent of the decline, and increased labor productivity caused 29 percent of the decline (table 7).

Together, these real changes were responsible for 34 percent of the decline in labor intensity. However, two-thirds of the decline in labor-intensity estimates was due to the effect of price increases as described above. Land intensity between 1982 and 1977 fell from 4,298 to 3,537 acres (table 5).

The way the percentages in table 7 are estimated is best illustrated with an example. Consider the estimate that 5 percent of the change in labor intensity between 1977 and 1982 was attributable to changes in commodity composition. We derived this by first calculating labor intensity for 1982 using the 1982 commodity composition, while holding productivity and prices at their 1977 levels. The difference between the resulting estimate and the 1977 labor intensity is due to the change in commodity composition. We then express this difference as a percentage of the actual change in labor intensity between 1977 and 1982.

Between 1977 and 1982, two-thirds of the decline in the labor-intensity estimates and three-fourths of the decline in the land-intensity estimates resulted from price changes. The remaining third of the change in labor intensity between 1977 and 1982 resulted from real changes, most of which were higher labor productivity. The remaining one-fourth of the decline in land intensity was the net result of the effect of changes in commodity composition and land-productivity (yields) changes moving in opposite directions. The negative percentage represents a significant shift toward land-intensive commodities. This shift was an increase in the share of food grains, principally wheat, in 1982 exports. By itself this shift would have resulted in higher land intensity. However, an even greater increase in crop yields offset this effect, leaving the real changes with a net negative effect on land intensity.

Between 1977 and 1987, there was also a decline in labor and land intensity. However, real factors were the predominant causes in this case. Increased productivity offset the effects of a shift toward more labor- and land-intensive commodities. Between 1982 and 1987, labor intensity increased but land intensity declined. Increased labor productivity, by itself, would have lowered labor intensity, but the effect of price changes offset its effect. Lower prices for major commodities (primarily food, feed, and oil crops) in 1987 than in 1982 meant that a million dollars bought a larger quantity of these goods and hence required higher labor use. Higher crop yields and a shift in commodity composition away from the land-intensive food, feed, and oil crops caused land intensity to fall over the same period. But the overall

changes in labor and land intensity were small between 1982 and 1987, so the percentage changes resulting from the large and conflicting changes in each of the three elements were large.

Thus, changes in commodity composition, prices, and factor productivities determine changes in the factor intensity of agricultural exports between years. For a given year, however, the factor intensity of agricultural exports to different countries differs because of different commodity compositions (table 8). Each million dollars of agricultural exports to the Soviet Union in 1987, for example, required 7,252 harvested acres compared with only 2,784 acres for exports to Western Europe. This difference occurs because most agricultural exports to the Soviet Union are food and feed crops, the most land-intensive commodities, while Western Europe imports a more varied basket of goods that includes commodities that are much less land intensive than food crops. Similarly, agricultural exports to Africa are very land intensive, 5,700 acres per million dollars, because most agricultural exports to Africa are food grains.

An important aspect of the factor use required by agricultural exports is not only the economywide labor or land required, but also the sectoral location of these land and labor requirements. The industries requiring the land and labor, of course, depend on the commodity composition of exports.

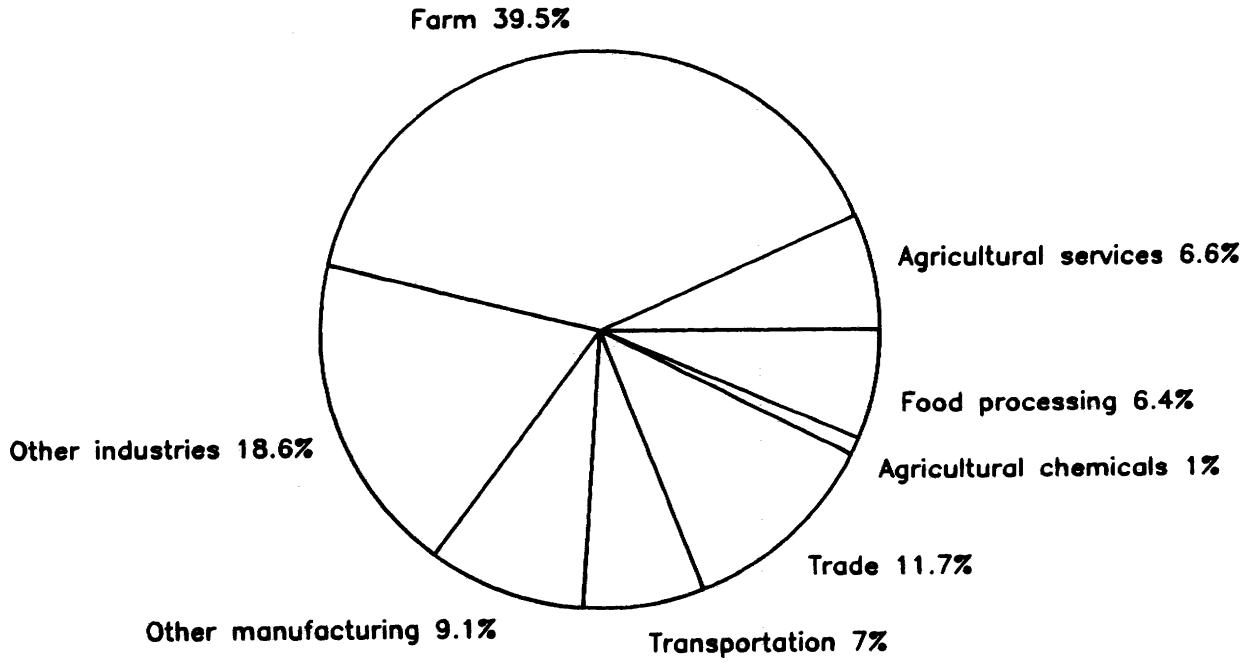
Because of the interconnections among industries in the economy, however, the employment of factors often occurs in industries far removed from the industry producing the final export good. For example, meat product exports require production from the livestock industry, which in turn requires production from the feed grain sector, which requires production from the fertilizer industry, and so on.

Figure 5 shows the sectoral distribution of the 884,000 workers required to produce 1987 agricultural exports. About 40 percent of the employment occurred in the farming sector, with another 7 percent in agricultural services. Food processing industries accounted for 6 percent and agricultural chemicals, which include fertilizer and pesticides, 1 percent. Trade and transportation services, needed to move output through the chain of production

Table 8--Labor and land intensity required for $1 million in U.S. agricultural exports, by destination, 1977-87, selected years

Destination	Workers			Harvested acreage		
	1977	1982	1987	1977	1982	1987
	Number			Acres		
Canada	46.9	32.2	28.2	1,729.4	1,145.8	1,057.2
Mexico	39.9	30.4	31.3	4,547.0	3,016.8	3,669.6
Western Europe	36.4	28.1	27.4	3,982.8	3,415.5	2,783.9
Japan	39.4	30.5	31.7	4,522.5	3,323.3	3,305.4
South Korea	43.2	33.0	35.0	4,999.6	3,791.8	3,951.9
USSR	41.0	30.0	38.2	7,514.9	5,320.8	7,251.5
Africa	40.3	29.4	34.4	4,996.3	4,038.3	5,699.7

Figure 5
Employment resulting from U.S. agricultural exports, 1987

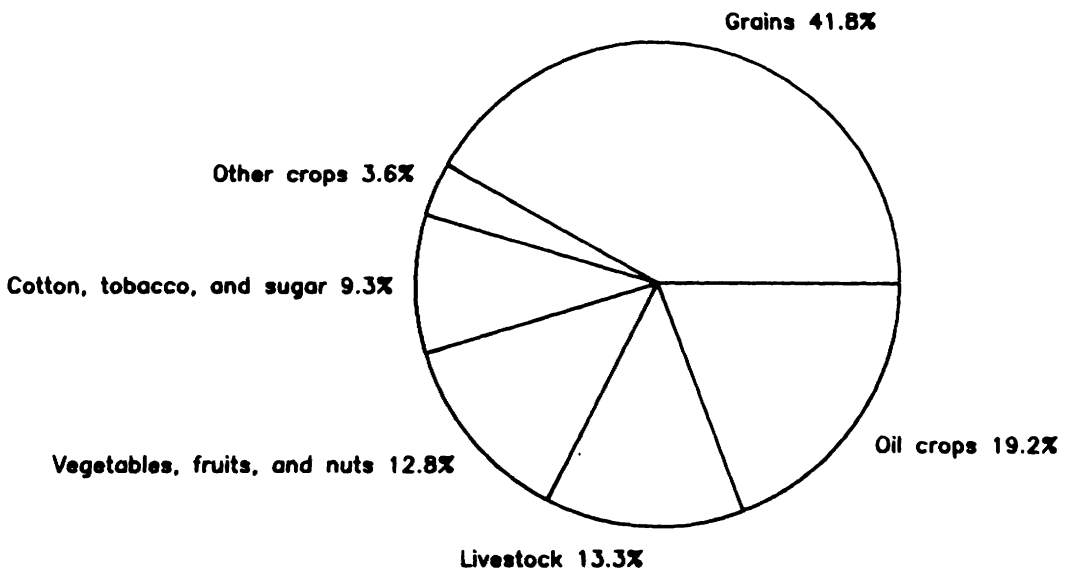


linking farm output to foreign buyers, accounted for 19 percent of the employment. The remaining 28 percent of employment occurred in diverse manufacturing and service industries throughout the economy.

Although the composition of agricultural exports determines where the required employment will occur, it does not necessarily give an accurate picture of the sectoral composition of employment. For example, processed foods were 30 percent of the value of agricultural exports in 1987 but food processing accounted for only 6 percent of the required employment (fig. 4). Similarly, exports of farm products were over two-thirds of the value of 1987 agricultural exports, but only 40 percent of the employment required occurred in the farm sector. Finally, although all the exports considered were either farm or food products, 47 percent of the employment required by those exports occurred outside the farm and food sectors.

A closer look at employment within the farm sector also points out the differences between the share of a commodity in exports and its share of employment. Agricultural exports in 1987 required an estimated 349,400 workers in the farm sector. Oil crops were 16 percent of the value of agricultural exports and accounted for 19 percent of export-related farm employment. However, food grain and feed grain production made up 25 percent of agricultural exports but employed 42 percent of the farm labor for exports (table 4, fig. 6). Similarly, livestock production accounted for only 2 percent of agricultural exports but comprised 13 percent of farm employment for exports. These

Figure 6
Farm employment resulting from U.S. agricultural exports, 1987



differences between the relative importance of a commodity in exports and its importance in farm employment related to exports reflect the different direct and indirect labor requirements for commodities. For example, livestock exports are small but large exports of meat products require significant production and employment in the livestock sector which in turn require production and employment in feed production and other industries.

Agricultural Exports and the Leontief Paradox

An important theoretical issue involving the factor intensity of trade is the Leontief Paradox. According to a line of theory associated with Heckscher and Ohlin (1, 4, 5, and 19), a country will export goods which require the intensive use of its relatively abundant and cheap factor and import goods that require the intensive use of its relatively scarce and more expensive factor. In a pioneering study, Leontief (5) used input-output analysis to estimate the capital and labor intensities of U.S. exports and imports. Because analysts commonly perceived the United States to be abundant in capital and scarce in labor, Leontief expected the capital-to-labor ratio of U.S. exports to be greater than that of imports. The surprising contrary result became known as the Leontief Paradox.

Leontief's findings led many to question his methodology. Two criticisms in particular stand out. First, Leontief used a model with only two factors, labor and capital, abstracting from other factors such as natural resources. If a commodity intensively used a natural resource, then classifying it simply as labor or

capital intensive would be misleading. Vanek (19) takes this position. He suggests returning to the traditional triad of land, labor, and capital in analyzing factor intensities. Stern (10) argues that capital and labor are needed to modify natural resources to give them economic value but that different countries may combine these factors in different proportions when producing natural resource-based products.

A second criticism is that Leontief's finding of capital-intensive imports may reflect the U.S. tariff policy rather than factor abundance. Kravis (4) found that the most heavily protected industries in the United States were labor-intensive industries. A tariff on labor-intensive imports would reduce imports of these goods and stimulate domestic production, biasing the pattern of trade toward capital-intensive imports. Numerous empirical tests of the factor content of U.S. trade have given mixed results. Some confirmed Leontief's finding for earlier years but refuted it for recent years (1, 6).

This section examines the Leontief Paradox within the context of agricultural trade. Using factor-output coefficients for labor, land, and capital, it is possible to examine the factor intensity of U.S. agricultural exports for 1982. Using the same procedure, one can estimate the factor intensity of U.S. agricultural imports assuming they had been produced using domestic technology. The rationale for this procedure is to gain insight into why the U.S. imports the commodities that it does.

According to the Heckscher-Ohlin theory, imports should consist of goods that require the intensive use of the factor that is relatively scarce and expensive in the United States, namely labor. If this proposition holds, then estimating the factor intensity of agricultural imports as if they were produced domestically should show those commodities to have a higher labor/capital ratio than do U.S. agricultural exports, making them cheaper to import than to produce domestically. The factors examined here include capital as well as labor and land. We measure capital use here as purchases of new structures, machinery, and equipment. Competitive agricultural imports, agricultural goods that are comparable with domestic production, totaled $9.6 billion in 1982 (11). Only competitive imports are considered because in principle they can be produced domestically. Figures 7 and 8 show the composition of U.S. agricultural exports and competitive agricultural imports for 1982.

Table 9 presents the results of this analysis for 1982. Each item in the first three columns measures the economywide use of the factor in that column needed to produce $1 million of agricultural exports or imports. The final two columns present the ratios of these measures. The most important result to notice is that agricultural exports have higher capital-to-labor and land-to-labor ratios than do agricultural imports. Over $7,000 in capital purchases and 118 harvested acres per worker were required for each million dollars of agricultural exports compared with less than $6,000 and 26 acres for imports. These

Figure 7
U.S. agricultural exports, 1982

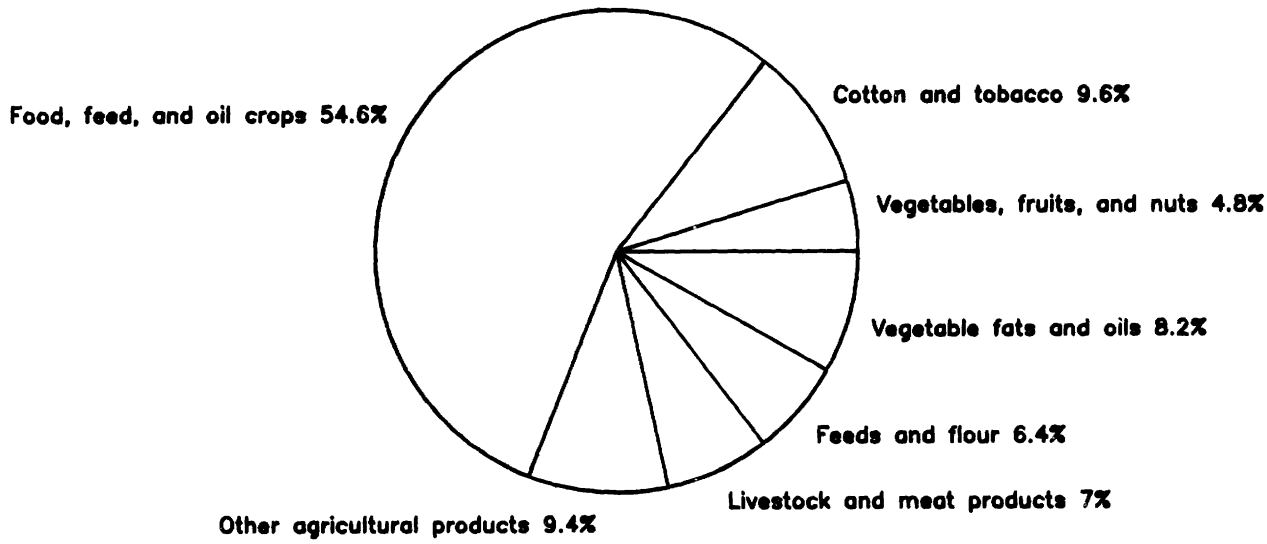


Figure 8
U.S. competitive agricultural imports, 1982

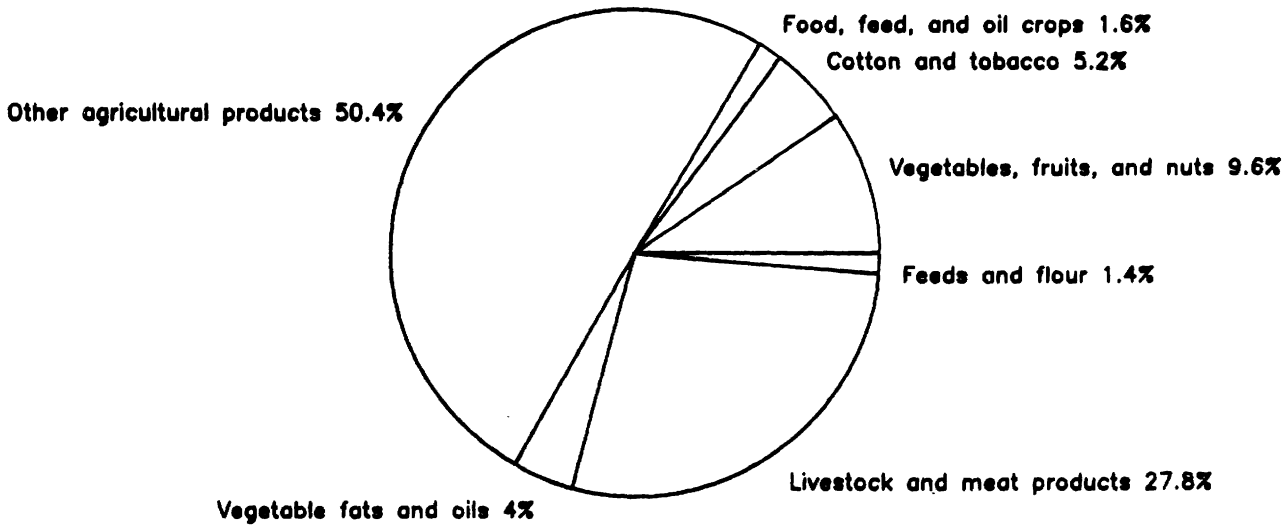


Table 9--Factor intensity per million dollars of U.S. agricultural trade, 1982

Item	Labor	Land	Capital	Capital-to-labor ratio	Land-to-labor ratio
	Workers	Acres	Dollars	Dollars per worker	Acres per worker
Exports	30.0	3,537	217,765	7,259	118
Imports	29.6	766	168,863	5,705	26
			Ratio		
Exports/imports	1.01	4.62	1.29	1.27	4.56

results reflect the composition of agricultural exports and imports. Exports are dominated by farm products, which require higher economywide capital purchases than do processed food products, which are dominant in agricultural imports. A lower capital-to-labor ratio for imports is equivalent to a higher labor-to-capital ratio for imports than exports, which confirms the Heckscher-Ohlin theory of trade. Thus, the Leontief Paradox does not hold for U.S. agricultural trade. U.S. agricultural exports are capital and land intensive compared with U.S agricultural imports.

Conclusions

The factor intensity of agricultural exports is defined as the total amount of a factor required economywide to produce a representative $1 million of exports. In 1977, each million dollars of U.S. agricultural exports required an estimated 39 workers and 4,300 harvested acres of cropland. For 1987, agricultural exports had a labor intensity of 31 workers and a land intensity of 3,500 harvested acres. Changes over time in estimates of factor intensity reflect changes in prices, commodity composition, and factor productivity.

In spite of a shift toward commodities that require more land and labor, increases in labor productivity and crop yields were responsible for most of the difference in labor and land intensity between 1977 and 1987. Higher factor productivity lowers required factor use. Higher prices in 1987 than in 1977 also contributed to the decline in factor intensity estimates.

Differences in the factor intensity of agricultural exports to specific nations within a given year reflect differences in commodity composition. The land intensity of agricultural exports in 1987 to USSR, mostly food and feed grains, required over 7,200 acres. In contrast, each million dollars of agricultural exports to Canada, largely fruits and vegetables, required only about 1,000 acres.

By calculating the land, labor, and capital purchases associated with the production of agricultural exports and imports and comparing these, a test of the Leontief Paradox for U.S. agricultural trade can be made. In 1982, U.S. agricultural

exports had an estimated capital-to-labor ratio of $7,259 per worker compared with $5,705 for imports, a ratio of 1.3. The land-to-labor ratio for exports was 118 acres per worker compared with 26 acres per worker for agricultural imports, a ratio of 4.6. These calculations indicate that the United States exports agricultural goods that are capital and land intensive and imports agricultural goods that are labor intensive.

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Appendix I: Estimating Procedures

Input-output (I-O) analysis is the basic procedure used in this study to estimate factor use for agricultural exports. The original 537-sector U.S. I-O table for 1977 (17) is aggregated into a 47-sector model which emphasizes industries that produce food and fiber products. These 47 sectors were combined into 12 agricultural product groups for ease of presentation.

Base Year Estimation

The estimation procedure for factor use for 1977 agricultural exports is as follows.

$$E = e(I-A)^{-1}BX, \quad (1)$$

$$L = l(I-A)^{-1}BX, \quad (2)$$

where:

E = an n x 1 vector of workers required in each industry to produce agricultural exports.

L = an n x 1 vector of harvested acres in each crop sector to produce agricultural exports.

e = an n x n diagonal matrix of hired and unpaid family workers per dollar of sector output coefficients.

l = an n x n diagonal matrix of harvested acres per dollar of crop output coefficients.

$(I-A)^{-1}$ = an n x n I-O total requirements matrix.

B = an n x m export bridge of shares of each export commodity produced by each industry.

X = an m x 1 vector of agricultural exports.

Nonbase Year Estimation

To estimate the factor use required for agricultural exports in 1982 and 1987 it is necessary to adjust for changes in prices, labor productivity, and crop yields. Nonbase year factor use is estimated through a modification of equations (1) and (2).

$$E = R \; e \; O, \tag{3}$$

$$L = Y \; l \; O, \tag{4}$$

where:

R = the inverse of an n x n diagonal matrix of indexes of output per worker with 1977=100.

Y = the inverse of an n x n diagonal matrix of indexes of crop production per harvested acre with 1977=100.

$$O = P(I-A)^{-1} \; B \; X, \tag{5}$$

where:

P = the inverse of an n x n diagonal matrix of sector price indexes with 1977=100.

Capital Use Estimation

Capital use for 1982 agricultural exports and imports is measured by purchases of machinery, equipment, and structures.

$$K_x = k \; P \; (I-A)^{-1} \; B \; X, \tag{6}$$

$$K_m = k \; P \; (I-A)^{-1} \; B \; M, \tag{7}$$

where:

K_x = an n x 1 vector of sector purchases of machinery, equipment, and structures to produce 1982 agricultural exports.

K_m = an n x 1 vector of sector purchases of machinery, equipment, and structures that would have been required to produce 1982 agricultural imports domestically.

M = an m x 1 vector of competitive agricultural imports.

k = an n x 1 vector of machinery, equipment, and structure purchases per million dollars sectoral output.

Labor and Land Use Estimation

Estimates of labor and land intensity (labor and land use per million dollars of agricultural exports) for 1977, 1982, and 1987 are derived from equations (1), (2), (3), and (4),

where:

X = an n x 1 vector totaling $1 million, prorated from the actual export value for each year.

Appendix II: Data Sources

The agricultural trade data used in this report correspond to official published USDA trade statistics (11). Agricultural commodities are defined as nonmarine food products and farm products that have not gone through complex manufacturing processes. In addition to the commodities usually thought of as agricultural, such as fruits, grains, and fibers, commodities such as raw hides and skins, fats and oils, and beer and wine are included in the definition. However, manufactured products such as textiles, forestry products, cigarettes, and distilled alcoholic beverages are not included. The export data include commodities produced domestically and commodities of foreign origin that have been modified in the United States. The import data represent imports for consumption and are based on the foreign market value, exclusive of U.S. import duties and charges incurred in transporting the commodities to the United States. Only competitive imports are included, products that are similar to those produced domestically or significantly interchangeable with domestic commodities. This is because using U.S. production relations to estimate the factor intensity of agricultural imports only makes sense when the commodities are actually producible in the United States.

In order to use the trade values in the analysis, they are first grouped into the appropriate producing industries among the 47 sectors using trade bridges from the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) (17) that link Schedule B commodity codes to I-O codes. Then, using coefficients from BEA (17), estimates of the trade and transportation services required to bring the products to market are derived and subtracted from the purchase value of the trade data, leaving the value of exports and imports in producers' prices. Price deflators are used to convert these values to 1977 dollars, the base year of the I-O model. For food grains, feed grains, cotton, tobacco, and oilseeds, price indexes were derived using data on the value and quantity of exports from USDA (11). For the other farm commodities, indexes of prices received by farmers are used. For manufactured commodities, price indexes are derived from (18).

Employment

The employment estimate for each industry is derived from a labor coefficient that measures the number of workers per million dollars of output in 1977. The coefficients were derived using employment and output data from the Bureau of Labor Statistics (BLS) (18). In order to incorporate changes in labor productivity since 1977, indexes of output per worker in each industry are used to adjust the estimates of labor use resulting from equation 1. Employment estimates include wage and salary workers as well as unpaid family workers, which are especially important in farming.

Land

Estimates of harvested acres needed to produce agricultural exports and imports are derived using coefficients that measure harvested acres per unit of crop output in 1977. The coefficients were derived using acreage data from USDA (14) and output data from BEA (17). In order to account for differences in crop yields since the base year 1977, indexes of yields were created using yield data from USDA (14).

Capital

Estimates of expenditures by industries on new structures and equipment are from the 1977 capital flow table from BEA (9). The capital flow table disaggregates gross private domestic investment to show the flow of structures and equipment from the producing to the purchasing industries. Using industries are identified at the two-digit I-O industry level. Because the sector scheme used by this study requires the separation and regrouping of some six-digit I-O industries, it was necessary to do the same with capital expenditures. In order to do this, expenditures on new plant and equipment by corresponding Standard Industrial Classification (SIC) industries from the 1977 Census of Manufactures were used to distribute the two-digit industry control totals among the six-digit component industries. This was done to ensure that the capital expenditures were consistent with the I-O accounts.

The capital flow table contains estimates of capital purchases for only two farm sectors: livestock, which includes dairy, meat animal, poultry, and miscellaneous livestock; and other agricultural products which include the crop sectors. To distribute the livestock and crop estimates among their component sectors, we obtained data on farm capital purchases by type of farm from the 1978 Census of Agriculture (15), the last census for which such data are available. We used census estimates of machinery, motor vehicle, and structure purchases by type of farm to obtain the share of total capital purchases bought by each farm type. We then used these shares to distribute the capital flow table estimates for livestock and crops. These estimates were then updated to 1982 by using data from the 1982 Census of Manufactures (16), estimates of fixed reproducible tangible wealth (8), output data (17), and crop acreage (14).

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